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BOTTLE ROCKET LAUNCHER

BACKGROUND INFORMATION

FIELD OF THE INVENTION

[0001] The present invention generally relates to the field of rocket launchers and more particularly to multi-stage rocket launchers and more particularly to parallel or ganged multi-stage rocket launchers.

DESCRIPTION OF PRIOR ART

[0002] Rocket launchers are popular with hobby enthusiasts and are used as educational tools to engage students in discovering the laws of physics while solving practical engineering problems. The dramatic release of stored energy during a launch enthralls students. This will peak student interest and lead students to questions concerning physical properties such as acceleration, inertia, friction, aerodynamic drag, and flight distance. Students gain experience in engineering by designing and testing their own nose cones, recovery systems or stabilizing fins.

[0003] Budgetary restraints require school systems to purchase inexpensive educational systems. In spite of some restraints the apparatus must be safe to use and rugged enough to withstand years of laboratory and field use. Several bottle rocket launchers are known. **Kaye (U.S. Patent 2,927,398; 1960)** discloses a multi-stage bottle rocket launcher. There are several disadvantages of the Kay system: It lacks versatility and economy of design by not allowing use with a conventional soda bottle. The geometry of the design is complex making it expensive to manufacture. There is no mechanism to prevent pressure leaks from the second-stage into the first stage prior to its separation from the first stage. The base is a combination pressure pump as well as a lock and release mechanism. The Kaye design does not allow use of pressure pumps, such as the ordinary bicycle type, which are widely available. A safety issue exists due to the close proximity of the pressure pump and pressurized rocket body.

[0004] **Jones (U.S. Patent 6,315,629; 2001)** discloses a single stage rocket launcher. There are several disadvantages of the Jones launcher. The release mechanism is not suitable for multi-stage applications. The release mechanism utilizes pivotable gripping levers that require assembly thereby increasing costs. Pressurization and water filling is not provided by the same fueling line. The pressure gauge is located at the base of the launcher therefore reading the gauge requires being in close proximity of the pressurized rocket. The safety pin and the release mechanism are attached to a single pull line. The base is not adjustable for uneven terrain. The base can not be adjusted to vary the launch angle.

[0005] Prior art discloses no launcher that is capable of launching rockets with stages greater than two. No launcher is capable of simultaneously launching rockets in parallel either singly or ganged. No launcher is capable of launching multistage-ganged rockets. There is no launcher capable of adjusting the lift off angle or leveling the launcher for uneven terrain. Furthermore, no launcher supplies a charging system that utilizes a single line for both liquid and gas charging. Nor do the launchers provide a pressure gauge a safe distance from the pressurized rocket. The disclosed launchers are structurally more complicated and thus increases the cost of manufacture.

[0006] What is needed is a launcher that is inexpensive, rugged, modular and safe to operate. What is further needed is a launcher that can adjust to the variability of launch conditions. What is still yet further needed is a launcher capable of launching single stage rockets or simultaneously launching multiple, single stage rockets or launching multiple, multistage rockets as well as ganged rockets or ganged multistage rockets.

SUMMARY OF THE INVENTION

[0007] Accordingly it is the primary object of the invention to provide a bottle rocket launching system that is safe to operate, modular in design, easy to assemble and affordable. A further object of the invention is to provide a launcher capable of launching single stage rockets or multistage rockets. A still further object is to provide a launcher able to simultaneously launch several single-stage or multi-stage rockets as well as launch a ganged single stage or a ganged multi-stage rocket as a single unit. An even further object is to provide a charging station that safely charges all first-stage and subsequent stage rockets.

[0008] In accordance with the teachings herein, the present invention provides a bottle rocket launching system with a plurality of pivotable supports. Said pivotable supports are capable of adjusting for uneven terrain or changing the launch angle. The bottle rocket launching system provides a modular, capture and release mechanism that is utilized in single rocket launches, all stages of multi-stage launches, and in ganged rocket launches. Said bottle rocket launching system has a charging station used to charge bottles of the ordinary soda bottle type or any other vessel of similar construction, with fluids such as water and compressed gas. Said charging station is located a safe distance from charged rocket and charges through a single line. Said charging station is equipped with a pressure reading device.

[0009] In greater detail, the support structure has a support hub that has a plurality of pivotable supports circumferrentialy placed. Said pivotable supports are attached to support hub with ordinary fasteners. The pivotable supports are adjusted for uneven terrain or are set to change the launch angle and are secured in position by said ordinary fasteners.

[0010] The capture and release mechanism, in the preferred embodiment, is comprised of a capture and release core with a plurality of ordinary seal rings. Said seal rings prevent fluid leakage from the launch vessel prior to launch. Said capture and release mechanism has a central bore that allows passage of charging fluids into rocket vessel. Said capture and release core supports flexible retainers that are circumferentially placed around said capture and release core.

[0011] The capture and release mechanism is secured to the support structure by a capture and release fastener. Said capture and release fastener is inserted into the lower end of the release core. Charging fluid is prevented from escaping said capture and release fastener and support structure contact area by ordinary seal rings. The capture and release fastener has a central bore that allows passage of charging fluid into said capture and release core. Said capture and release fastener has internal means to prevent charging fluid from flowing back from the rocket vessel.

[0012] Said flexible retainers provide a lock means to secure the rocket vessel to said support structure when rocket vessel is pressurized with compressed gas. The rocket vessel can be an ordinary soda bottle or any vessel with a flange capable of communication with said flexible retainers. A capture and release cup is slid into position that is furthest away from support structure. When in this position the flexible retainers will rest inside said capture and release cup. The inner side walls of the capture and release cup prevent radial movement of the flexible retainers thereby locking the ends of the flexible retainers around the flange located on the neck of the rocket vessel. In this lock position, the rocket vessel is prevented from launching when the rocket vessel is pressurized with compressed gas.

[0013] A launch-actuating device is provided to remotely launch the rocket vessel from a safe distance. Said launch actuating device may be any device that causes movement of the capture and release cup downward towards the support structure.

Said launch-actuating device may be a simple tether, such as a string, or a more complicated mechanism such as an electrical or electronic device may also be used.

[0014] A safety control clip is inserted to insure that the capture and release cup is maintained in this lock position. In the preferred embodiment the safety control clip fits partially around the release core between the capture and release cup and the support structure or the previous stage rocket vessel and thereby prevents downward movement of the capture and release cup. Said safety control clip is controlled remotely by any safety release device that would allow removal of said safety control clip. The simplest said safety release device would be a tether such as a string or a more complicated said safety release device such as an electrical or electronic device may also be used. Said safety release device can be independent of said launch actuating device. This embodiment increases safety during launch operations by placing launch approval, removal of said safety control clip, and launch initiate, by downward motion of said capture and release cup, under separate, independent control. The aforesaid description is complete for a single stage rocket.

[0015] If desired, a second-stage may be added. Said second-stage is added to the first-stage by providing a mounting hole in the end of said first-stage rocket vessel that is opposite to the thrust orifice. The modular design of said capture and release mechanism allows said capture and release mechanism to be mounted in said mounting hole. Said second-stage capture and release mechanism is mounted in the same manner described for the single stage rocket. An additional safety control clip is used to prevent premature release of the second-stage rocket. An additional safety release device is needed to remove said additional safety control clip. For reasons to be explained below there is no launch-actuating device required for said second-stage operation.

[0016] Subsequent stages may also be added. To add three or more stages, mounting holes are provided in the rocket vessel end, opposite to the thrust orifice end, of every stage except the last stage. Identical capture and release mechanisms

are mounted in said mounting hole as described above. The safety control clip is identical to previous stages with the following exception. A stage separation delay device is incorporated into said safety control clip. Said stage separation delay device replaces said safety release device. Said stage separation delay device would be a simple tether that is attached to said third-stage safety control clip and to some point on the first stage rocket vessel. If subsequent stages are incorporated an additional separation delay device is needed. For example, a fourth-stage would require a stage separation delay device to be connected to the fourth-stage safety control clip with the other end of the stage separation device connected to the second-stage rocket. In this embodiment subsequent stage safety control clips prevents movement of the capture and release cup, of said subsequent stages, until the previous stage separation has occurred. More elaborate methods for stage separation delay devices such as an electrical or electronic device may also be used. Stage separation is discussed in greater detail below.

[0017] A charging station is provided to fill the said first-stage rocket vessel with liquid propellant and all stages with pressurized gas. Said charging station has two inlets and a single outlet. One inlet provides a connection to a liquid propellant source, usually water or any non-reactive liquid, and the other inlet provides a connection to a compressed gas source. Said compressed gas may be air or any other inert gas. Said charging station single outlet is connected to the central bore of said first-stage capture and release fastener. Said charging station has internal back flow prevention devices to ensure that the liquid propellant does not enter the compressed gas source and the compressed gas does not enter the liquid propellant source. A pressure gauge is mounted on said charging station to allow reading of the rocket vessel pressure at a safe distance from the pressurized rocket vessel.

[0018] Operation of a three-stage rocket launch is as follows. Mount first-stage rocket vessel by placing bottle rocket neck orifice over capture and release core until flexible retainers are in communication with bottle neck flange. The capture and release cup is then slid up to the lock position. The safety control clip is then place

around capture and release core bottom. The safety release device is attached the safety control clip and in the case of a simple tether is lead to a position a safe distance away from the multi-stage water rocket system.

[0019] The second-stage is mounted by first partially filling the second-stage rocket vessel with liquid propellant. The second-stage rocket vessel outlet orifice is slid around the second stage capture and release core, mounted on first-stage rocket vessel, opposite the thrust orifice end, until flexible retainers are in communication with bottle neck flange on second-stage rocket vessel. The capture and release cup is then moved to the lock position. The safety control clip is then placed around the capture and release core between the second stage capture and release cup and the first stage rocket vessel. The safety release device is attached to the second stage safety control clip and is led to a safe distance away from the multi-stage water rocket system.

[0020] The third-stage rocket vessel is mounted on the second-stage rocket vessel in the same manner as the second-stage rocket vessel is mounted on the first-stage rocket vessel. The stage separation delay device, in this embodiment, is a simple tether with one end connected to the third stage safety control clip and the other end of said stage separation delay device fastened to the first-stage rocket assembly. The connection may be made to the first-stage rocket vessel or the capture and release core mounted on the first-stage rocket vessel.

[0021] The first-stage rocket vessel is charged with liquid propellant using the said charging station. Liquid propellant passes from the liquid propellant source into the said charging station inlet through the said charging station internal back flow prevention device. Liquid propellant then exits the said charging station and enters the said first-stage capture and release fastener central bore via the said charge line. The charge line connects charging station to the multi-stage water rocket system. Liquid propellant enters the first-stage rocket vessel via the capture and release core central

bore. Liquid propellant is prevented from flowing back into the charge line by the back flow prevention means located in the capture and release fastener.

[0022] All stages are charged with compressed gas using the charging station. Compressed gas passes from the compressed gas source into the charging station compressed gas inlet. Compressed gas passes through the charging station second back flow prevention device. Compressed gas exits the charging station and enters the charge line. The charge line is connected to the first-stage capture and release fastener central bore. Compressed gas passes through the capture and release fastener back flow prevention device and enters the capture and release core central bore. The compressed gas exits the capture and release central bore and flows through the liquid propellant already contained within the first stage rocket vessel. The compressed gas accumulates in the space above the liquid propellant in the first-stage rocket vessel. The compressed gas enters the capture and release fastener central bore, mounted on the first-stage rocket vessel, and charges the second-stage rocket vessel with compressed gas in the same manner described above. Compressed gas charges the third-stage rocket vessel in the same manner as the second-stage rocket vessel. All stages are now charged with compressed gas. The multi-stage rocket system is ready for launch. It should be noted that the above explanation of operation is the same for any amount of stages incorporated.

[0023] The multi-stage rocket system is safely launched using the following procedure. Safety control clips are removed from the first-stage and the second-stage, capture and release mechanisms. The removal is initiated by actuating the respective safety release device. The multi-stage rocket system is now launched by actuating the first-stage launch-actuating device. The launch actuating device causes the first-stage capture and release cup to move to the launch position. The flexible retainers are no longer restrained from radial movement. The force caused by the pressurized gas in the first-stage rocket vessel causes all three stages to move upward. This upward movement will cause the first-stage rocket vessel 101 to separate from the capture and release mechanism 110 mounted on the support

structure 104. Upon separation, liquid propellant is forced from the first-stage rocket vessel orifice by the compressed gas in the first-stage rocket vessel. All three stages well accelerate upward.

[0024] Upon initial acceleration the second-stage capture and release cup will move downward to its' release position. The second-stage is now free to separate from the first-stage but is prevented from doing so because the force of acceleration is greater than the force caused by the compressed gas in the second stage. At some point in the flight, the force caused by the compressed gas in the second-stage rocket vessel will be greater than the force of acceleration tending to keep the stages together. At this point the second-stage will separate from the first-stage and accelerate away from the first-stage carrying the third-stage with it.

[0025] Upon the initial separation of the second-stage from the first stage, the third-stage safety control clip is automatically removed. This is accomplished by the stage separation delay device connected between the first-stage and the safety control clip on the third stage. As the second and third-stage accelerate, the capture and release cup of the third-stage will slide down to its release position. The third-stage will separate and accelerate from the second-stage when forces are balanced in the same manner described above for first and second-stage separation. Additional stages operate in the same manner as the third stage.

[0026] The modular design of the capture and release mechanism allows operation in a parallel launch configuration. To accomplish this, any number of capture and release mechanisms can be mounted so rocket vessels can be loaded onto the capture and release cores without interference. The capture and release cups are connected with a coupling plate so that all capture and release mechanisms can be moved as a unit. All capture and release cups are held in the capture position by placing one safety control clip under the coupling plate. A safety release mechanism is attached to the safety control clip. A launch-actuating device is attached to the coupling plate. Placement of launch and release mechanisms with an

associated coupling plate allows for parallel launches of multiple single stage rocket vessels, multiple multi-stage rockets or multiple rocket vessels ganged as a single rocket. Ganged rockets may also be multi-stage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The present invention is described in detail with the accompanying drawings. Identical numbers are used to reference components that are functionally equivalent. In should be noted that the drawings are not drawn to scale.

[0028] **FIG. 1** is an isometric view of a multi-stage rocket system with three-stages.

[0029] **FIG. 2** is an exploded view of a single stage rocket launch system.

[0030] **FIG. 3A** is a partial cross sectional view of the capture and release mechanism in the lock position.

[0031] **FIG. 3B** is a partial cross sectional view of the capture and release mechanism just as the rocket is released.

[0032] **FIG. 4** is an exploded view of a second-stage or subsequent stage capture and release mechanism.

[0033] **FIG. 5** is a cross sectional view of the capture and release core and a capture and release fastener.

[0034] **FIG. 6** is a cross sectional view of the charging station.

[0035] **FIG. 7** is an isometric view of a multi-stage rocket system with three stages immediately after launch, just as the rockets are accelerating upward.

[0036] **FIG. 8** is top view of a coupling plate use to gang seven or three rocket configurations.

[0037] **FIG. 9** is a cross sectional view of a capture and release fastener used in parallel launch base showing lateral port for receiving charging fluids.

[0038] **FIG. 10** is a cross sectional view of a capture and release fastener used in the center position of a parallel launch showing charging line and lateral port for supplying peripheral rockets.

[0039] **FIG. 11** cross sectional top view of a parallel launch support structure showing internal charging channels.

[0040] **FIG. 12** is an isometric view of a parallel launch system configured for a seven-rocket vessel launch.

[0041] **FIG. 13** is an isometric view of a parallel launch system with rocket vessels mounted in the locked position.

DETAILED DESCRIPTION OF THE INVENTION

[0042] Referring to **FIG. 1,** a multi-stage water bottle rocket system **100** is shown in a three-stage configuration. Although this detailed description explains a three-stage configuration, it is understood that additional stages are possible and that the multi-stage water bottle rocket system **100** is not limited to three stages.

[0043] The multi-stage water bottle rocket system **100** has a support structure **104**. The support structure **104** has a plurality of circumferentially mounted pivotable supports **105**. Pivotable supports **105** are attached to support hub **107** using ordinary fasteners **106**. The pivotable supports **105** are adjusted using ordinary fasteners **106**. The pivotable supports **105** are used to level the multi-stage water bottle rocket

system **100** for uneven terrain or to vary the launch angle. The support hub **107** also provides an attachment point for capture and release mechanism **110**.

[0044] The capture and release mechanism **110** is used in every stage of the multi-stage water bottle rocket system **100**. The capture and release mechanism **110** is discussed in greater detail below.

[0045] First-stage rocket vessel **101**, second-stage rocket vessel **102** and third-stage rocket vessel **103** may be any vessel that has the ability of withstanding pressurization and that is capable of communication with capture and release mechanism **110**. Example of said vessel is an ordinary soda bottle or an ordinary water cooler bottle of any size or shape but said vessel is in no way limited to these types of vessels. The said rocket vessels are discussed in greater detail below.

[0046] Safety release device **113** is provided so that the safety mechanism incorporated in the capture and release mechanism **110**, discussed below, can be actuated from a safe distance from the launch site. The safety release device **113** may be a simple tether; an electrical or electronic device or any mechanism capable of communication with the safety mechanism incorporated in capture and release mechanism **110**.

[0047] The stage separation delay device **114** functions to delay separation of any stage, greater than the second stage, incorporated in the multi-stage water rocket system **100**. The stage separation delay device **114** may be a simple tether, an electrical or electronic device or any mechanism capable of communication with the capture and release mechanism **110** that provides the proper timing for separation. The separation delay device is discussed in more detail below.

[0048] The launch-actuating device **112** functions to initiate a launch by communicating with capture and release mechanism **110**. The launch actuating device **112** ensures the launch is initiated a safe distance from the pressurized vessel.

The launch-actuating device **112** may be a simple tether, an electrical or electronic device. The launch-actuating device **112** may be any mechanism capable of launch communication with the capture and release mechanism **110**.

[0049] Charging station **108** provides a means for remotely charging the first-stage rocket vessel **101** with liquid propellant. The charging station **108** provides a means for charging the first-stage rocket vessel **101**, the second-stage rocket vessel **102**, the third-stage rocket vessel **103**, as well as any additional stage rocket vessel, with compressed gas. Said liquid propellant may be any liquid. The preferred liquid is generally water or any liquid that does not pose a hazard to operating personnel or observing bystanders. Said compressed gas may be any compressed gas, generally air or any compressed gas that does not pose a hazard to operating personnel or observing bystanders. Charging station **108** has two inlets. Charging station **108** liquid inlet **115** is connected to any suitable liquid source. Charging station **108** compressed gas inlet **116** is connected to any suitable compressed gas source. Charge line **109** is the fluid outlet for charging station **108**. Charge line **109** is connected to capture and release mechanism **110** via the capture and release fastener **201**, shown in **FIG. 2**. Charge line **109** provides a means for liquid propellant or compressed gas to be fed into the multi-stage water bottle rocket system **100**, a safe distance from the pressurized vessel. Charging station **108** is fitted with an ordinary pressure gauge **111**. Incorporating the ordinary pressure gauge **111** in the charging station **108** allows reading of the pressure supplied to multi-stage water bottle rocket system **100** a safe distance from the pressurized vessel. Charging station **108** has internal back flow prevention devices. The back flow prevention devices are discussed in greater detail below.

[0050] Referring to **FIG. 2**, the capture and release mechanism **110** has a capture and release core **205**. The capture and release core **205** has a top **205A** and a bottom **205B**. The capture and release core top **205A** is fitted with a plurality of rocket vessel orifice seal rings **209**. The capture and release core top **205A** is inserted in the rocket vessel orifice **206** until first-stage rocket vessel **101** mates with the capture and

release core step **210**. In this position the capture and release core seal rings **209** function to prevent liquid propellant and compressed gas from escaping the first-stage rocket vessel **101**.

[0051] The flexible retainer mechanism **204** has a central orifice **204A** and a plurality of circumferencially placed flexible retainers **204C**. Each flexible retainer **204C** has a curved tip **204B**. Capture and release core bottom **205B** is inserted into flexible retainer central orifice **204A** until flexible retainer mechanism **204** mates with capture and release core step **210**. When the flexible retainer mechanism **204** is in this position the curved tip **204B** grips rocket vessel flange **207**. The assembled unit is comprised of the first-stage rocket vessel **101**, the capture and release core **205** and the flexible retainer mechanism **204.** The assembly is slid, as a unit, into the capture and release cup **203** until the capture and release cup **203** inner bottom mates with flexible retainer mechanism **204**. When the capture and release cup **203** mates with the said assemble mechanism, the top of the capture and release cup **203** is flush with the top of the flexible retainer mechanism **204**. The capture and release fastener **201** is led into the ordinary seal **202** and the entire assembly is fed into bottom of support hub **107** and led into the support hub central orifice **211**. The capture and release fastener **201** is led into the support hub central orifice **211** until fastener step **201B** mates with inside bottom surface of the support hub **107**. Ordinary seal **202A** is placed around fastener top **201A** and led down until the ordinary seal **202A** mates with the top surface of support hub **107**. Ordinary seals **202** and **202A** prevent liquid propellant and compressed gas from escaping the assembly. The capture and release mechanism **110** is secured to the support structure **104** by anchoring the fastener top **201A** into the capture and release core bottom **205B**.

[0052] In this configuration, the capture and release cup **203** is free to move between the following limits. The capture and release cup **203** is at the upper limit of its' travel when the inside bottom of the capture and release cup **203** mates with the bottom of the flexible retainer mechanism **204**. This is the capture position and the pressurized first-stage rocket vessel **101** is prevented from launching. The capture

and release cup **203** is at the lower limit of its' travel when the outside bottom of the capture and release cup **203** mates with the top of the support hub **107**. This is the release position and the pressurized first stage rocket vessel **101** is no longer restrained. The movement of the capture and release cup **203** is explained in greater detail below. When the capture and release cup **203** is in the capture position, the safety control clip **208** is placed around the capture and release core bottom **205B**. The safety control clip **208** when placed around the capture and release core bottom **205B** prevents movement of the capture and release cup **203** to its release position and thereby prevents release of the first-stage rocket vessel **101**.

[0053] **FIG. 3A** and **3B** shows the capture and release mechanism **110** with the capture and release cup **203** cross-sectioned. **FIG. 3A** shows the capture and release cup **203** in the capture position. When the capture and release cup **203** is in the capture position and the first-stage rocket vessel **101** is charged with liquid propellant and compressed gas, the forces acting on the mechanism must be balanced. The pressure of the compressed gas in the first-stage rocket vessel **101** creates a force tending to separate the first-stage rocket vessel **101** from the capture and release core **205**. The first-stage rocket vessel **101** is prevented from separation because the flexible retainer tip **204B** extends above the rocket vessel flange **207** and thereby grabs the rocket vessel flange **207**. The forces acting between the flexible retainer tip **204B** and the rocket vessel flange **207** tend to force the flexible retainer tip **204B** radially outward due to the sloped surface of the flexible retainer tip **204B**. The flexible retainer tip **204B** is prevented from moving radially outward by the capture and release cup sidewall **304**. When the safety control clip **208** is removed, the capture and release cup **203** will remain in the capture position. The capture and release cup **203** remains in the capture position due to the friction between the capture and release cup side wall **304** and the plurality of circumferentially placed flexible retainers **204C**.

[0054] **FIG. 3B** shows the first-stage rocket vessel **101** just as it is released from the capture and release mechanism **110**. If sufficient force is applied, in a direction

parallel to the axis of the capture and release cup **203**, and away from the rocket vessel, **101**, the capture and release cup **203** will move towards the release position. As the capture and release cup **203** begins to move, the flexible retainer tip will begin to move radially outward as the first-stage rocket vessel **101** begins to move upward. The flexible retainers **204C** will impart a downward force on the capture and release cup bevel **305**. This downward force will cause the capture and release cup **203** to move downward with increased speed. This action allows the flexible retainers **204C** to move further radially outward. The outward movement of the flexible retainers **204C** causes an increase in the force acting downward on the capture and release cup bevel **305**. Therein the capture and release cup **203** is forced to move toward the release position at a greater speed. In other words, the design of the capture and release mechanism **110** is such that any initial downward movement of the capture and release cup **203** creates a downward force on the capture and release cup bevel **305**. This downward force on the capture and release cup bevel **305** is created by the outward splaying of the flexible retainers **204C**. The advantage is that minimal downward force on the capture and release cup **203** is required to initiate a launch. The first-stage rocket vessel **101** will no longer be constrained from launch at some point in the downward travel of the capture and release cup **203**. The capture and release cup **203** has a capture and release cup flange **302**. The capture and release cup flange functions as a stop for the coupling plate discussed later.

[0055] Referring to **FIG. 4** the capture and release mechanism **110** is shown as it is mounted on the first-stage rocket vessel **101**. The parts are identical to the capture and release mechanism **110** mounted on the support structure **104** with the one addition. The delay device anchor **402**. The delay device anchor **402** has an anchor attach tab **402A**. The anchor attach tab **402A** provides a means of attachment for the stage separation delay device **114** (see **FIG. 1**). A rocket vessel hole **401** provides a means for securing the capture and release mechanism **110** to the first-stage rocket vessel **101**.

[0056] To assemble the capture and release mechanism **110**, used in a second-stage or subsequent stage application, place the ordinary seal **202** around fastener top **201A** until ordinary seal **202** rests against fastener step **201B**. The capture and release fastener **201** is then fed through the rocket vessel orifice **206**, of first-stage rocket vessel **101**. The fastener top **201A** is inserted through the rocket vessel hole **401** until the ordinary seal **202** mates with inside surface of first-stage rocket vessel **101**. The delay device anchor **402** is placed around the fastener top **201A** until the delay device anchor **402** mates with the top of the first-stage rocket vessel **101**. The ordinary seal **202A** is placed around the fastener top **201A** until the ordinary seal **202A** mates with the delay device anchor **402**. The remainder of the capture and release mechanism **110** is assembled in the same manner for first-stage operation described above. When assembled the second stage capture and release mechanism **110** is attached to the first-stage rocket vessel **101**. The capture and release mechanism **110**, in this second-stage application, provides a means for controlling the separation of the second-stage rocket vessel **102** from the first-stage rocket vessel **101**. The capture and release mechanism **110** used in this second-stage application also provides a means for compressed gas to flow into the second-stage rocket vessel **102** from the first-stage rocket vessel **101**. Back flow of liquid propellant or compressed gas from the second-stage rocket vessel **102** into the first-stage rocket vessel **101** is prevented by the back flow prevention mechanism inside the capture and release fastener **201**. The back flow prevention is discussed in greater detail below. It should be noted that the capture and release mechanism **110** used in a third-stage application, or any subsequent stage application, is identical in construction and assembly to the capture and release mechanism **110** used in a second-stage application.

[0057] **FIG. 5** shows a cross section of the capture and release core **205** and the capture and release fastener **201**. The capture and release fastener **201** has a central bore **505**, a back flow stop **501**, a back flow seal **502** and a back flow stop retainer **503**. The back flow stop **501** is free to travel between the back flow seal **502** and the back flow stop retainer **503**. The central bore **505** provides a path for fluid passage

between the charge line **109**, when used in first-stage application, or a path for compressed gas passage when used in any subsequent stage application. When fluid enters the central bore **505** and flows towards the release core central bore **504**, the black flow stop **501** is moved towards back flow stop retainer **503**. The back flow stop retainer **503** prevents the back flow stop **501** from leaving the capture and release fastener **201**. When fluid attempts to flow from the release core central bore **504** back to the release fastener central bore **505** the back flow stop **501** is forced down and mates with the back flow seal **502**. This action prevents fluid flow from the release core central bore **504** back to the release fastener central bore **505**. Therefore, any liquid propellant or compressed gas that is admitted, therein, to any stage rocket vessel, **101**, **102**, **103** or subsequent stage, will remain in the rocket vessel. The liquid propellant or compressed gas will remain in the rocket vessel as long as the rocket vessel is in communication with the capture and release mechanism **110**.

[0058] **FIG. 6** shows a cross sectional view of the charging station **108**. The charging station **108** has two charging station hose adapters **601**, two charging station back flow housings **602** and one charging station central core **607**. The charging station hose adapter **601** has a connection orifice **608**. The connection orifice **608** provides a connection point for the charging station liquid inlet **115** and the charging station compressed gas inlet **116**. The charging station hose adapters **601** are attached to charging station back flow housing **602** by an appropriate mechanical means such as threads or adhesives that will provide a fluid seal. The charging station back flow housing **602** contains a charging station back flow seal **604**, a charging station back flow stop **603** and a charging station back flow retainer **605**. The charging station back flow stop **603** rests against the charging station back flow retainer **605** when fluid is entering the connection orifice **608**. The charging station back flow retainer **605** prevents the charging station back flow stop **603** from leaving the charging station back flow housing **602**. When fluid is flowing into one charging station back flow housing **602**, from the associated charging station hose adapter **601**, the other charging station back flow stop **603** is forced against the charging station back flow seal **604**. With the charging station back flow stop **603** against the charging

station back flow seal **604** no fluid is allowed to flow from that associated charging station back flow housing **602** into the associated charging station hose adapter **601**. Thus fluid flowing into charging station compressed gas inlet **116** is prevented from flowing out of charging station liquid inlet **115**. In addition, when liquid is flowing into charging station liquid inlet **115**, the liquid is prevented from flowing out of charging station compressed gas inlet **116**. It follows that any fluid that enters charging station **108** must exit charging station **108** via charge line **109**. The charging station **108** has an ordinary pressure gauge **111** mounted on the charging station central core **607**. Placement of the ordinary pressure gauge **111** on charging station central core **607** provides a remote means of pressure measurement that is a safe distance away from the pressurized rocket vessel.

[0059] Referring in general to **FIG. 1**, **FIG. 2**, **FIG. 4**, **FIG. 5**, **FIG. 6** and **FIG. 7** the operation of the multi-stage rocket launcher **100** is as follows. The pivotable supports **105** on the support structure **104** are adjusted for the desired launch angle. As describe above the capture and release mechanism **110** is attached to the support structure **104**. In addition, as described above the capture and release mechanisms **110** are attached to the first-stage rocket vessel **101** and the second-stage rocket vessel **102**.

[0060] Insert first-stage rocket vessel orifice **206** over the capture and release core **205** that is mounted on support structure **104** until first-stage rocket vessel flange **207** is gripped by the flexible retainer tip **204B**. Slide the capture and release cup **203** to the capture position. Place the safety control clip **208** around the capture and release core bottom **205B**. The capture and release mechanism **110** that is attached to the support structure **104** is now set in the pre-launch condition.

[0061] Fill the second-stage rocket vessel **102** partially full with liquid propellant and insert the second-stage rocket vessel **102** over the capture and release core **205** that is mounted on top of the first-stage rocket vessel **101**. Capture the second-stage

rocket vessel **102** in the same manner described in the previous paragraph. The second-stage rocket vessel **102** is now in the pre-launch condition.

[0062] Fill the third-stage rocket vessel **103** partially full with liquid propellant and insert the third-stage rocket vessel **103** over the capture and release core **205** that is mounted on top of the second-stage rocket vessel **102**. The third-stage rocket vessel **103** is captured in the same manner described above. The stage separation delay device **114** is a simple tether in this embodiment. The stage separation delay device **114** is attached to the safety control clip **208** that is clipped to the capture and release core **205** that is mounted on top of the second–stage rocket vessel **102**. The other end of the stage separation delay device **114** is attached to the delay device anchor **402**, anchor attach point **402A**. All three stages of the multi-stage water rocket system are now ready for charging. It should be noted that the above procedure is applicable for single-stage launches as well as two-stage launches, or more stage launches.

[0063] The first-stage rocket vessel **101** is charged with liquid propellant by allowing liquid propellant to enter the charging station liquid inlet **115**. Liquid propellant will flow into the charging station **108**, through charging station internal back flow prevention mechanism internal to the charging station back flow housing **602** and out of charging station **108** via the charge line **109**. Liquid propellant flows from the charge line **109** into the release fastener central bore **505**. Liquid propellant flows through release fastener central bore **505** and into the release core central bore **504**. Liquid propellant exits the release core central bore **504** and enters the first-stage rocket vessel **101**. Liquid propellant is allowed to flow until first-stage rocket vessel **101** is partially full of liquid propellant.

[0064] First-stage rocket vessel **101**, the second-stage rocket vessel **102**, and third-stage rocket vessel **103** are simultaneously charged with compressed gas by first allowing compressed gas to flow into the charging station **108** via the charging station compressed gas inlet **116**. Compressed gas flows through the charging station **108** internal back flow prevention device that is internal to the charging station back

flow housing **602** and exits the charging station **108** via charge line **109**. Compressed gas flows into the release fastener central bore **505**, of the capture and release fastener **201**, that is mounted on the support structure **104**. The compressed gas then flows into the release core central bore **504**. Compressed gas then enters the first-stage rocket vessel **101**.

[0065] From the first-stage rocket vessel **101** compressed gas passes through the capture and release mechanism **110** mounted on top of the first-stage rocket vessel **101** in the same manner described in the previous paragraph. The compressed gas then enters the second-stage rocket vessel **102**. The compressed gas passes through the capture and release mechanism **110** mounted on the top of the second-stage rocket vessel **102** in the same manner just described. The compress gas then enters the third-stage rocket vessel **103**. In this manner, all rocket vessels on all stages are simultaneously charged with compressed gas to the same pressurization level. The multi-stage water rocket system **100** is now ready for launch.

[0066] Referring to **FIG. 7**, the operator must first use the safety release device **113** to remove the safety control clip **208**, that is associated with the capture and release mechanism **110** mounted on the support structure **104**. The other safety release device **113** is used to remove the safety control clip **208** that is associated with the capture and release mechanism **110** mounted on top of the first-stage rocket vessel **101**.

[0067] Actuating the launch actuating device **112** causes the capture and release cup **203**, associated with the capture and release mechanism **110** mounted on the support structure **104**, to move to the release position. This will allow the first-stage rocket vessel, **101**, the second-stage rocket vessel **102**, and the third-stage rocket vessel**103** to accelerate upward as a single unit.

[0068] Upon the initial acceleration the capture and release cup **203**, associated with the capture and release mechanism **110** mounted on the top of the first-stage

rocket vessel, will move to the release position. The second-stage rocket vessel **102** is prevented from separation from the first-stage rocket vessel **101** because the force of acceleration, which acts to keep the stages together, is greater than the force tending to separate the two stages. The force tending to separate the two stages is caused by the compressed gas in the second-stage rocket vessel **102**. At some point in the flight the force caused by the compressed gas in the second-stage rocket vessel **102** will exceed the force of acceleration. When the force of the compressed gas, in the second stage rocket vessel **102**, exceeds the force of acceleration the second-stage rocket vessel **102** will separate from the first-stage rocket vessel **101**. The second-stage rocket vessel **102** will accelerate upward carrying the third-stage rocket vessel **103** and the associated capture and release mechanism **110** with it.

[0069] Upon this second-stage separation, the stage separation delay device **114** will remove the safety control clip **208**, associated with the capture and release mechanism **110** mounted on top of the second-stage rocket **102**. This action occurs at the very start of second-stage rocket vessel **102** separation. The capture and release cup **203**, associated with the capture and release mechanism **110**, mounted on top of the second-stage rocket vessel **102**, is no longer restrained in the capture position. The acceleration forces exerted will cause this capture and release cup **203** to move to the release position. The third-stage rocket vessel **103** will separate in the same manner describe above for the second-stage rocket vessel **102**.

[0070] It should be noted that this invention would operate with one, two, three or more stage rockets. The invention is not limited to the description above.

[0071] The modularity of the capture and release mechanism **110** allows the capture and release mechanism **110** to be used in a parallel launch configuration. The following explanation describes one embodiment of the capture and release mechanism **110** used in a parallel launch configuration. It should be noted that the capture and release mechanism **110** could be used in a parallel launch configuration of any number of rocket vessel configurations. Parallel configurations using first-stage

rocket vessels **101**, second-stage rocket vessels **102** and third-stage rocket vessels **103** as well as additional stages are possible.

[0072] **FIG. 8** is a top view of a coupling plate **801**. The coupling plate **801** has a launch actuating device orifice **802**, coupling plate peripheral orifices **803**, a coupling plate central orifice **804**, and coupling plate inner orifices **805**. The coupling plate **801** is used to connect a number of capture and release mechanisms **110**, capture and release cups **203** to each other. When several capture and release cups **203** are connected with a coupling plate **801** only one safety control clip **208** is required to control the launch. Only one launch-actuating device **112** is required to initiate a launch. In order to gang seven, first-stage rocket vessels **101** together the six coupling plate peripheral orifices **803** and the coupling plate central orifice **804** are used to connect the seven capture and release mechanisms **110**. To create a parallel launch using three, first-stage rocket vessels **101**, the three coupling plate inner orifices **805** are used to connect the three capture and release mechanisms **110**. Operation of a parallel launch is discussed in greater detail below.

[0073] **FIG. 9** is a cross sectional view of a capture and release peripheral fastener **901**. The capture and release peripheral fastener **901** has a central bore **902** and a radial bore **903**. Charging fluid enters the capture and release peripheral fastener **901** through the radial bore **903** and charging fluid exits the peripheral fastener **901** via the central bore **902**. The capture and release peripheral fastener **901** is used to attach the capture and release mechanism **110** for a parallel launch configuration described in greater detail below.

[0074] **FIG. 10** is a cross sectional view of a capture and release central fastener **1001**. The capture and release central fastener **1001** has a bottom bore **1002**, a top bore **1003**, and a radial bore **1004**. The charging line **109** is attached to the bottom bore **1002**. Charging fluid enters the capture and release central fastener **1001**, bottom bore **1002**, from the charging line **109**. Fluid passes from the bottom bore **1002** and exits the capture and release central fastener **1001** through the top bore

1003. Fluid also exits through the radial bore **1004**. Incorporation of the capture and release central fastener **1001** into a parallel launch system is discussed below.

[0075] **FIG. 11** shows a cross sectional top view of the parallel launch support structure **1103**. The parallel launch support structure **1103** has a plurality of circumferentially placed parallel launch support structure struts **1101**. The parallel launch support structure **1103** has a circumferential inner channel **1104**, circumferential connecting channels **1105**, and radial inner channels **1108**. The parallel launch support structure **1103** has a central orifice **1107** and a plurality of circumferentially placed peripheral orifices **1109**. The parallel launch support structure **1103** also has an actuating orifice **1110**, inner orifices **1106**, and a plurality of circumferentially placed strut orifices **1111**.

[0076] Now referring to **FIG. 9**, **FIG. 10**, and **FIG. 11**, in the embodiment shown, the parallel launch support structure **1103** may be used in a seven, first-stage rocket vessel **101** configuration. Six capture and release mechanisms **110** are attached to the parallel launch support structure **1103** in the support structures peripheral orifices **1109** with capture and release peripheral fasteners **901**. The method of attachment is the same as described above for a single capture and release mechanism **110** attachment. The remaining capture and release mechanism **110** is attached to the support structure central orifice **1107** using capture and release central fastener **1001**. The method of attachment is the same described above for a single capture and release mechanism **110** attachment.

[0077] A plurality of pivotable supports **105** are attached to the parallel launch support structure **1103**, with ordinary fasteners **106**, by placing pivotable supports **105** between the struts **1101**. Pivotable supports **105** are secured by placing ordinary fasteners **106** through the strut orifice **1111** and tightening ordinary fasteners **106**. Pivotable supports **105** may be adjusted to accommodate for uneven terrain or to vary the launch angle by moving pivotable supports **105** to desired position and securing with ordinary fasteners **106**.

[0078] The parallel launch system is completed by placing a coupling plate **801** over the capture and release mechanisms **110**, until the coupling plate **801** rests on the capture and release cup flange **302**. The final assembly is shown in **FIG. 12**.

[0079] Referring to **FIG. 12,** the coupling plate **801** connects all the capture and release mechanisms **110** together. All the capture and release mechanisms **110** are held in the capture position by a single safety control clip **208**. A launch is initiated by a single launch-actuating device **112**. In the embodiment shown the launch actuating device **112** is a simple tether which is passed through the support structure actuating orifice **1110** and attached to the coupling plate **801** at the launch actuating device orifice **802**. The safety control clip **208** is removed, by actuating the safety release device **113**. The coupling plate **801** and the coupled capture and release mechanisms **110** are now free to move downward as a single unit, but are held in the capture position, as described above for a single stage launch. Actuating the launch-actuating device **112** causes the coupling plate **802** to move downward. The coupling plate **802** will transmit this downward movement to all the capture and release mechanisms **110**. All capture and release mechanisms **110** will move to the release position simultaneously. Any charged first-stage rocket vessel **110** will then be free to accelerate away from the parallel launch system **1200**. A complete description of charging and launching the parallel launch system is described below.

[0080] Referring to **FIG. 9, FIG. 10, FIG. 11, FIG. 12**, and **FIG. 13**. With the parallel launch system **1200** assembled as described above. The charging of the first-stage rocket vessels **101** is accomplished simultaneously through the charge line **109**. The charge line **109** is attached to the capture and release central fastener **1001**. The capture and release central fastener **1001** is attached to the center capture and release mechanism **110** via the support structure central orifice **1107**. Charging fluid enters the capture and release central fastener **1001** bottom bore **1002** from the charge line **109**. Any first-stage rocket vessel **101** in charging communication with the capture and release mechanism **110** that is mounted on the capture and release

central fastener **1001** is charged with fluid via the central fastener upper bore **1003**. Charging fluid exits the capture and release central fastener **1001** through the central fastener radial bore **1004** and enters the radial inner channels **1108**. The charging fluid flows through the radial inner channels **1108** to the capture and release peripheral fasteners **901** mounted in the support structure peripheral orifices **1109**. The charging fluid leaves the radial inner channel **1108** and enters the peripheral fastener radial bore **903**. The charging fluid then passes into the peripheral fastener central bore **902** and then enters the capture and release mechanism **110** that are in charging communication with the capture and release peripheral fasteners **901**. The charging fluid then enters any first-stage rocket vessel **101** captured by the capture and release mechanisms **110**. The symmetrical design of the channels in the parallel launch support structure **1103** ensures that all rocket vessels are charge with the same amount of liquid propellant and compressed gas.

[0081] For a parallel launch configuration, with three first-stage rocket vessels **101**, the capture and release mechanisms **110** are mounted in the support structure inner orifices **1106**, using capture and release peripheral fasteners **901**. In this configuration, the charge line **109** is connected to lateral orifice **1112**. Charging fluid leaves the charge line **109** and enters the lateral orifice **1112**. Charging fluid leaves the lateral orifice **1112** and enters circumferential inner channel **1104**. Charging fluid flows through the circumferential inner channel **1104** and enters the circumferential connecting channels **1105**. The circumferential connecting channels **1105** feed charging fluid into the peripheral fastener radial bore **903**, of the capture and release peripheral fasteners **901**, that are mounted in the support structure inner orifices **1106**. Charging fluid leaves the capture and release mechanism peripheral fastener **901** via the peripheral fastener central bore **902**. The charging fluid then enters the capture and release mechanism **110** that is in charging communication with the said capture and release peripheral fasteners **901**. The charging fluid then enters the first-stage rocket vessel **101** in the same manner described above.

[0082] It should be noted that the invention is not limited to a seven ganged or three-ganged rocket vessel launch described above. The modular design of the lock and release mechanism **110** allows a multiplicity of configurations. Such configurations may be comprised but are not limited to ganged launches consisting of multiple rockets of one, two or more stages simultaneously launched or grouped as a single multi-engine rocket. Subsequent stages may be single or grouped as multi-engine rockets.